

Distributive Concerns When Replacing a Pay-As-You-Go System with a Fully Funded System

Salvador Valdés-Prieto

How is income distribution affected if you replace a progressive social security program that redistributes income toward the poor (but is financed by a pay-as-you-go method) with a neutral social security program that is fully funded?



Summary findings

Valdés-Prieto uses a simulation model to quantify the impact on income distribution of having a neutral social security program that is fully funded replace a progressive social security program that redistributes income toward the poor but is financed by a pay-as-you-go method.

He finds that if the original pay-as-you-go system is large enough to yield an income replacement rate of at least 40 percent for the middle class and 200 percent for the poor, then the proposed change helps the poor in the long run, so long as public debt does not increase by more than 40 percent of GDP during the transition.

Such a reform allows an increase in the capital stock per worker, so in the long run the poor benefit more

through higher real wages than they lose because progressive redistribution has ended. In the short run, however, a compensatory program is needed because the poor lose their subsidy before receiving the long-term benefit.

In most cases, the 40 percent of GDP available from the increase in public debt is enough to finance a transfer program that compensates the poor in the "short" run (the first 50 years).

Valdés-Prieto concludes that concern about the welfare of the poor is unwarranted, in both the short and long runs, if the compensatory program is implemented.

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Distributive Concerns When Replacing A Pay-As-You-Go System with a Fully Funded System¹

by Salvador Valdés-Prieto²

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² Professor of Economics, Instituto de Economía, U. Católica, Santiago, Chile.

1. Introduction

An important issue in the design of an old-age social security system is the handling of 'solidarity' or redistribution. As solidarity has many dimensions, the paper starts with a brief overview of several of them.

Section 2 offers a review of the long-standing discussion between two alternative methods to achieve redistribution in favor of the poor old. These are a conventional universal PAYG social security system, and a set of targeted transfer programs financed by progressive income taxation.

For some authors, the demand for egalitarian income redistribution implies that social security systems should presumably include as a first 'pillar' a conventional pension system, i.e. one that pays benefits according to a redistributive formula and is financed through the pay-as-you-go (PAYG) or unfunded method.

This presumption is unwarranted, because 'solidarity' could be provided through progressive taxes and transfers. If the volume and targeting of this redistributive channel is adjusted to achieve the desired degree of solidarity, the pension system may be charged with providing good pensions on an individualistic basis. The first 'pillar' of the social security system need not be a conventional PAYG system.

Section 2 also offers a discussion of redistribution between generations, presumably in favor of currently living generations because technical progress may lead one to expect that future generations will be richer. This presumption should be qualified, as technical progress has impoverished some countries and groups. Moreover, technical, medical and geological uncertainties suggests some precautionary saving is optimal.

One policy option is to redistribute towards those currently old by instituting a pension system financed with the pay-as-you-go (PAYG) method. This helps the generations currently alive because a cash surplus is generated during the first 30-50 years from initiation. The same can be achieved by increasing the size of an existing PAYG-financed pension system.

The alternative is a transparent transfer to the current generation financed with the issue of public debt, whose service is financed with future taxes. We find that when this choice has been made transparent, many countries have acted on the conservative side and refused to spend now the fruits of uncertain future wealth.

Given this groundwork, section 3 of the paper evaluates some of the redistributive implications of installing a fully funded pension system with individual accounts in replacement of a redistributive PAYG-financed pension system. As such a pension system doesn't redistribute income on its own, an important issue is whether the introduction of this scheme in replacement of a conventional PAYG pension system requires compensating the poor.

To answer this question, the paper uses a simulation model of a dynamic overlapping generations economy where three social classes coexist in each generation. In this general equilibrium model, there are three representative agents per generation, and 55 generations are alive at each point in time. The simulation is limited to compare welfare levels between steady states, and assumes there are no credit constraints (see Valdés-Prieto and Cifuentes (1993) for a discussion of the impact of credit constraints). Therefore, the simulations offer an exact measure of the long-run impact on the welfare of the poor.

Two opposing effects are apparent: first, the poor lose because the new pension system is not redistributive. This loss would occur only in countries where the initial PAYG system redistributes progressively, which is not true in many developing countries, as documented by other authors. The second effect is that the shift to a funded pension system may raise the stock of savings and the capital stock, provided the transition is financed with a limited issue of public debt and enough improvement of the primary fiscal balance. In this case the poor that live in the new steady-state are benefited through higher real wages and lower real interest rates.

We find that the poor that live in the long-run steady state do not require compensation if the public debt rises by less than 40 percentage points of GNP during the transition and the rest is financed with taxes, because the second effect dominates the first one.

Nevertheless, the poor that live in the transition require compensation, because they enjoy higher real wages to a lesser extent. Of course, this applies only if the initial pension system was progressive, which is not true in many developing countries. Based on the duration of similar transitions reported in the literature, we provide an estimate of the order-of-magnitude of the fiscal cost of the required compensation to the poor living during the transition. We find that the 40 percentage points of GDP available for compensation are enough to finance compensations for all the poor that live in the transition.

If this compensation is implemented, the middle class and the rich that are alive during the transition are the real losers from this pension reform. From a more general point of view, this exercise suggests that, in the case of pension reforms intergenerational redistribution is critical, while intra-generational distribution should not be a major cause for concern.

2. A review of redistribution in pension systems.

Although there is some discussion about the exact meaning of the term "social security", it is generally agreed that the two fundamental aims of social security programs are : (a) assuring insurance coverage for and sufficient savings to confront the main events that impair the living standards of workers, and (b) achieving greater equality through egalitarian income

redistribution. This redistribution can take place within a given generation or among generations ³.

Social security has been linked to income redistribution for many years in the English-speaking world. In his review, Atkinson (1987) classifies social security as a form of income maintenance, alongside private charity and public efforts like the English poor law of 1832, Britain's National Insurance Act of 1911, and the negative income tax proposed by Friedman in 1962. In his survey, Diamond (1977) acknowledges the income redistribution objective of the retirement portion of the US Social Security program, but points out that prominent features of the program cannot be explained on this basis, for example the fact that the highest pensions are paid to the wealthiest.

Other authors take a different view. Feldstein (1985) states that the essence of social security is compulsory savings and compulsory purchase of insurance. In the case of old-age pensions, the principal rationale for social security programs would be that some individuals lack the foresight to save for their retirement years.

To avoid problems of interpretation, we define social security as a program that levies taxes on earnings at a constant *rate*, regardless of the level of income and with no exemptions. On the expenditure side, we will adopt at face value Atkinson's (1987) assertion that "social insurance payments are not in general income-tested". This means that the social security benefit formula takes the form of a positive constant plus a figure proportional to past earnings. Because of the constant, the formula is redistributive. However, benefits are not income-tested in the sense that their level does not depend on the current level of total income of the individual old person. The term "targeting" will be reserved here for allowing differences in social security tax and benefit *rates* in response to income or wealth levels.

We review now the main conceptual issues regarding redistribution through social security. We take it as given that redistribution is one of the aims of the government.

2.1 Issues in intra-generational (standard) redistribution

The twin policies of targeted programs and a progressive income tax are a serious competitor to satisfy the redistributive aim of social security. For example the Brookings assessment of the 1972 US Budget proposal argued that "...universal payment systems are very inefficient... Tax rates would have to be raised simply to channel money from the family to the government and back to the family again." (cited by Kesselman and Garfinkel, 1978).

³ For some authors, most notably those close to the ILO (1984, statements N° 7,60 and 63), there is a third aim for social security, namely the alleviation of poverty. The alleviation of poverty is different from egalitarian income redistribution because the desire for redistribution between different income classes remains even when all classes meet their basic needs. However, this extension of the concept of social security is controversial.

This alternative method for redistributing toward the poor old has been adopted in some countries. Australia has an old age, invalidity and survivor pension program that is entirely financed through general revenue, while its benefits are income tested⁴. According to the ILO (1986), Australian social insurance programs are quite generous, as they cost 7.3 % of GDP in 1986⁵. Costa Rica, Chile, Hong-Kong and South Africa have similar programs, although they are much less generous.

There is a second group of countries that has chosen a non social-security type of financing for social-security type benefits. Denmark, New Zealand, Mauritius and Ireland have old age pensions benefits that are flat and universal, with very few means-tests, but they are financed through general revenue which includes a progressive income tax. The social-security approach is to finance those benefits through taxes on labor earnings alone using a flat rate.

A third combination is offered by the U.K., which uses part of the revenue from a progressive tax on labor earnings to finance a flat and universal basic pension. This program is not generous.

Some of these countries are dissatisfied with their current program. These programs are found wanting because they fail to meet an additional objective, which is to assure adequate pensions for the middle class. However, everybody agrees that their current programs have been successful in providing substantial assistance to the poor old.

This section does not intend to provide a full review of the venerable debate regarding the use of earnings-related pensions to redistribute income. However, we spell out the specific features of the debate for the case of old-age pensions.

2.1.1 Arguments against social security.

The three main arguments against using axes and transfers of the 'social security' type for redistribution within a given generation are the following:

(1) Coverage of taxes. The point here is whether general tax revenue can be collected in a more egalitarian way than contributions paid by salaried labor with a constant tax rate, as in conventional PAYG social security.

In most countries, and specially in developing countries, the tax system has wider coverage than the social security system. General taxes apply to a broader tax base that includes independent workers like professionals, shop owners, farmers, who pay either indirect or income taxes or both.

⁴ See Social Security Programs Throughout the World, 1985, page 10. There it is stated that means-testing of benefits was introduced as of March 21, 1985. However, we have been informed that the threshold is generous, so over 70% of old Australians pass the income test.

⁵ This estimate arises from the figure given by ILO, Table 3, for receipts for all social security programs, and then downsized by the ratio between the money receipts informed in Table 9 and in Table 8.

In most developing countries, the self-employed have low incomes, as they work as street vendors and subsistence farmers. These people usually pay some indirect taxes, although the absolute amount they pay is modest and their ability to evade is substantial. However, in most countries, the self-employed evade more easily the contributions to social security than indirect and income taxes. This difference is evident in the fact that social security legislation in almost every country gives the right to the self-employed to either decide the amount of their contribution or to contribute on a voluntary basis (ILO 1984, p. 16).

Up to here, general taxes seem to have the advantage of covering high-income independent workers. On the other hand, social security taxes have the advantage of exempting low-income independent workers. Specific economic conditions must be known to predict which tax system is more egalitarian.

Another difference arises from the treatment of non-wage compensation. In most countries the tax system limits the degree to which compensation paid in kind (health insurance, provision of a car, payment of schooling costs for children, food) can be exempted from the income tax. However, social security contributions are levied on the money wage, which is only a part of total compensation, so there is full exemption of non-wage compensation. If workers that contribute to social security have relatively high income, then this implies it is a less egalitarian system to raise revenue. The opposite happens if workers that contribute to social security are relatively low income.

One critical advantage of income taxes as compared with social security taxes is that the former can include a changing marginal tax rate. Social security taxes usually establish a single rate. This gives income taxes more flexibility to redistribute in a pareto efficient manner.

Summing up, except in countries where the contribution to social security is limited to high income workers, general tax collection has a larger potential to be egalitarian than contributions. This potential may or may not be realized by actual design and enforcement.

(2) Coverage of expenditure. Other government expenditure programs can be more egalitarian⁶ than conventional social security benefits because their coverage is wider. This is usually the case of targeted transfer programs, because they cover the poor old even if they have worked in the informal sector or been self-employed for long periods. Social security usually does not cover them because they have not contributed to social security for the required number of years.

This implies that a government that aims to achieve egalitarian redistribution towards the poor old needs a targeted program anyway, in addition to social security. Several countries in the OECD have established such programs.

⁶ Or alleviate poverty more effectively.

It should also be kept in mind that the assumption that social security expenditure favors lower income people is not true in many developing countries, as Mesa-Lago (1978) documents abundantly. Social security programs may go astray and end up favoring the middle income groups. It is conceivable that this could also happen in a targeted transfer program financed with general revenue, but it seems to occur much less frequently because of the design of targeted programs. The evidence reviewed by Grosh (1992) documents this fact.

(3) Conventional PAYG benefit formulas have a built-in bias against the poor. Conventional formulas typically pay benefits that are a linear function of the product of the number of years of contribution and the average wage over the last five or ten years before retirement⁷. This is regressive because of four reasons:

- a) The empirical evidence for OECD countries shows that the poor have a flatter lifetime income profile, apart from having a lower level of income. For example, see the evidence for the United States in Ehrenberg and Smith (1985). This means that a conventional benefit formula discriminates against the poor. The reason is that the poor get a lower pension as a ratio of average lifetime income, i.e. a smaller internal rate of return on their contributions.
- b) The poor have a shorter life expectancy. Therefore, a uniform retirement age in combination with the defined benefit formula discriminates against the poor. This is because the expected number of year of contributions, as a share of expected life, is higher for the poor, while the expected number of years of retirement is smaller.
- c) The poor usually begin to work younger, but are still subject to the same retirement age of other workers that go to college and contribute fewer years. This implies zero recognition for their early contributions. Even if benefits were based on an average of lifetime real earnings (adjusted by inflation) this would not recognize that contributions while young represent a consumption sacrifice for more years than contributions at age, say, 50. This implies that the poor should get more credit than in a lifetime average.
- d) The poor have less information and financial assets, so they are less able to take advantage of some of the rules of social security as commonly practiced. For example, take an old worker whose earnings are being counted for the average that defines his pension rights. If he becomes unemployed he will be unable to continue contributing if he is poor, losing substantial pension rights in addition to current earnings⁸. However if he has middle or higher income, owns some financial assets and has access to information about the loss of

⁷ This description does not include the large number of countries with a benefit formula that is substantially worse than this specification. For example, many countries base the pension on the average of the last three annual nominal covered incomes.

⁸ In the typical developing country there is no unemployment insurance, and if there is some it usually pays a very small benefit.

pension rights he could suffer, he will probably continue contributions out of his own funds⁹. The result is that ex-post the poor get fewer benefits.

The bottom line is that conventional PAYG defined-benefit systems need to incorporate some redistribution in the benefit formula just to compensate for these effects, and are less progressive than what may appear by analyzing the benefit formula alone.

2.1.2 Arguments in favor of social security.

There are three arguments in favor of using the conventional social-security type of taxes and transfers for redistribution within a given generation:

(A) High operating costs of targeted programs favor social-security type programs.

Conventional social security is believed to exhibit lower administrative costs than private insurance (Beveridge 1945; Valdés-Prieto 1993).

However, this is hotly debated when comparing social security with targeted transfer programs. Mesa-Lago (1990) reports administrative costs of 6-12% of total expenditure for PAYG Systems in Latin America. The targeting cost of programs to assist the old with cash transfers in developing countries is an under-researched topic. The Costa Rican program of pensions for the indigent elderly exhibits a targeting cost - the cost of screening new applicants - which is 10% of total administrative costs, or US\$ 13.60 per new successful applicant (Grosh, 1992, p. 76-77). The Chilean program of old age pensions for the poor (non-contributory) uses a proxy means-test and costs US\$ 5 per assessment (Grosh, p. 79). In the case studies of social programs where targeting or screening costs have been separated from administrative costs, the median cost was 1% of program expenditures. Some researchers conclude that "the concern with administrative costs has been greatly overstated" (Grosh, 1992, p. ix).

(B) Political Economy. It has been pointed out that conventional social security is more effective than targeted programs in gathering political support for income redistribution towards the poor old. The higher "political effectiveness" of conventional social security would be due to a feeling among voters that everybody has a stake in social security.

However, political economy arguments tend to be fragile. They are specially unconvincing when they are drawn from the particular experience of a few developed countries and are not supported by cross-country evidence.

The normal situation is for opinion-leaders to disagree about the desirable volume and direction of redistribution. In this setting the initial conditions

⁹ This should not be confused with the common practice by high-income people of using liquid funds and superior information to overreport income and inflate pension rights. For a low-income person, the only way to increase income in the critical years that enter her pension average is work overtime, which is very inequitable.

(i.e. the nature of the existing redistribution programs), and the differential information about the issues that is possessed by different interest groups, restrict the reform agenda, which in turn affects the outcome regarding both the volume of redistribution actually implemented and the direction of that redistribution.

One corollary is that, if the redistributive features of conventional social security are so obscure that the bulk of public opinion that does not like them can be goaded into accepting them, then public opinion can also be goaded to accept redistribution in favor of pressure groups of higher income. This has been the case in many developing countries, as documented extensively by Mesa-Lago (1978). The experience suggests that conventional social security, because of the obscurity of its benefit formulas and the associated redistributions, is more vulnerable to capture by pressure groups than targeted programs that assist the poor old in a transparent way.

Two other political issues are that targeting of benefits open up possibilities for: a) discrimination against some beneficiaries by the program personnel in exchange for the beneficiaries' votes; and b) use of the program benefits to pay off political services, by politicians who can press the program personnel through their influence in promotions. Problem (b) has surfaced in Costa Rica in the pension program for the indigent old (Grosh, p. 77). The fact that this does not seem to happen in other targeted programs in Costa Rica and other countries suggests that this might be prevented by appropriate design of the program itself and of the reward system for program employees.

In conclusion, the evidence suggests that in a number of cases a well-managed system of targeted transfers and progressive taxes can achieve the desired level of redistribution towards the poor old more efficiently than a well managed conventional PAYG pension system that pays universal transfers financed with wage taxes.

2.2 Issues in Inter-generational Redistribution

The introduction of an unfunded pension system generates a cash surplus during the first 30-70 years, as contribution revenue is available but no one has yet completed the required number of years of contributions to claim full pension benefits. This entails an inter-generational redistribution unless the government achieves the heroic political feats of saving the total of contributions by the first 30-70 years and of investing them in socially efficient investment projects.

In practice, the generation that gains from unfunded social security is the initial one, because it did not contribute enough but usually manages to receive full benefits from an early age.

The losing generations are those that live in the future. They have to live in an economy with less physical capital (closed economy case) or with higher external debt (open economy case), and therefore less GNP per capita. In the case of a closed economy this goes together with lower wages and higher real

interest rates. It should be noted that for the purpose of savings and investment, most countries are closed, as Frankel's survey (1992) shows. If the economy adopts an unfunded pension system while in the transition path of capital accumulation towards the steady state, a few additional generations can also gain (Fernández, 1980), but also at the cost of reducing the welfare of future generations.

Of course, it may be desirable to redistribute in favor of those currently alive. One standard argument in favor of this is that future technical progress will make future generations much richer. However, technical progress is uncertain, and other factors may make future generations worse off. For example, oil-producing kingdoms have decided to save a substantial portion of their oil revenue, as future depletion of reserves will make future generations worse off. As it is not desirable to consume the capital stock by refusing to replace depreciated equipment, it follows that redistribution toward the current generation must be undesirable at some point.

It is well known that the same type of inter generational redistribution is obtained when the government issues public debt and spends part or all the proceeds to benefit current generations (Diamond, 1965). This implies that PAYG-financed pension systems confront a significant competitor for fulfilling the aim of inter-generational redistribution, namely the issue of public debt coupled with the distribution of the proceeds through targeted transfer programs. The financing of the associated debt service can be assigned to progressive income taxation in the future.

The use of explicit government debt rather than implicit social security debt exhibits two advantages:

(1) Greater Transparency. Welfare losses suffered by future generations are much more evident and transparent when public debt is issued than when an unfunded pension system is started or expanded. To see this, one must recognize that issuing more public debt is equivalent to the following policy combination in a PAYG-financed social security: (a) raise the contribution rate transitorily, for one year; (b) raise the benefits promised to the generations that increased their contribution according to (a); (c) spend the transitory cash surplus that results to improve the welfare of some group in the present. The PAYG presentation hides the cost of meeting promise (b) that will force a tax increase on the generations alive in the future. It appears as if nobody pays.

The transparency issue can be also be assessed from the following perspective: Do we observe relatively rich generations using PAYG financing in reverse, to helping altruistically the poorer generations? Consider a generation which is unusually wealthy (may be because of a transitory commodity boom). For it, inter generational equity would imply that it legislates a reduction in its own social security benefits for the same current contribution, permitting a reduction in the future contributions of its children, while maintaining the benefits of its children. It is remarkable that no country has ever adopted these policies, in our knowledge.

On the other hand, expansions of social security financed with the PAYG method are routinely observed. This explains why PAYG financing has been described by some authors as a vehicle for intergenerational exploitation.

Now consider public debt. It has been observed in many countries that transitory income increases are used to pay off national debt. This was the case in England during the last three hundred years (Barro, 1986), Indonesia after the second oil shock, and Colombia during the 1978-80 coffee boom. This suggests that desirable inter generational redistribution is feasible through the public debt. The difference is that changes in the public debt are explicit, and therefore are a politically neutral vehicle for intergenerational redistributions that may go in any desired direction.

Note that the living generations could have argued against reducing national debt on the basis of the higher income that their children would enjoy due to future technical progress. The fact that many countries have still reduced their national debt when income rises transitorily suggests that this argument has been deemed spurious at least in those cases. This argument, which is routinely used to justify the issue of implicit debt by PAYG (unfunded) systems, appears overrated.

In theory, more opaqueness may favor any of the pressure groups involved in the democratic discussion of redistribution. In politics an opaque financing system offers an ideal setting for *"manipulation to gain the electoral support of a particular clientele, to legitimate a spurious political regime, and to satisfy the needs and coopt powerful pressure groups who threaten the status quo"* (Mesa-Lago, 1978, p. 3). It seems unlikely that more opaqueness leads to a better design in practice.

In addition, we would expect conventional PAYG-financed pension systems to be more exposed to failures of design because of their opaqueness. This can only be deleterious to the aim of achieving equitable inter-generational transfers.

(2) Inefficiency. The argument here is that it is inefficient to finance inter generational redistribution with the PAYG method, which taxes labor income, when it is feasible to finance inter generational redistribution with public debt, whose service is financed with more efficient general taxation. This point leads to a reedition of the arguments regarding intragenerational redistribution, surveyed in section 2.1.

3. Pension Systems and Income Redistribution

This section explains our simulation model and the parametrization of the income distribution. The main advantage of our model is that its parametrization is simple and reduces description to just two dimensions.

3.1 Structure of the simulation model

The simulation model used here is presented in the Appendix. It is a direct extension to three income classes of the Auerbach-Kotlikoff (1987) model, as applied by Arrau (1991) and Arrau and Schmidt-Hebbel (1993). It consists of a model economy with 55 overlapping generations, where people work from age 21 to 65 and then die at age 75. The representative agent of each generation supplies labor inelastically and saves in a utility-maximizing manner, with no concern for its descendants. Wages and interest rates adjust costlessly to clear the labor and capital markets. There are no credit constraints, so this simulation model is subject to the criticisms in Valdés-Prieto and Cifuentes (1993).

The government levies an income tax on earnings and income from capital, introducing a wedge between the interest rate paid by firms and the one received by investors. Tax revenue is used to finance current government consumption and to service the explicit public debt, which pays market interest rates.

The social security administration levies a tax on labor earnings alone (non-distortionary by assumption) and pays pensions according to a benefit formula that we choose to be progressive, favoring more the lower income class. The income tax is distortionary because it reduces the supply of savings, but wage taxes are not distortionary because labor is supplied inelastically.

A bias of this model is that the conventional PAYG system relies on wage taxes, which are not distortionary by assumption, while the fully funded system relies on income taxes, whose distortionary effect on investment is acknowledged in the model. Another bias is that in the fully-funded method we assume that interest income earned by pension funds is NOT exempt from income taxes. As this is not true in most countries, adoption of the fully funded financing method forces the government to compensate the reduction in the revenue base with higher tax rates, which increase distortions further. This extra distortion is avoided in this model. We hope that these biases compensate each other.

A detailed description of the simulation model is available in Arrau and Schmidt-Hebbel (1993). Note that the absence of borrowing constraints in this model, and the absence of tax exemptions for pension funds, implies that substituting the PAYG scheme by a funded and actuarially fair pension system is equivalent to a simple elimination of the social security system ¹⁰.

The parameter values for which no sensitivity analysis is performed are the elasticity of intertemporal substitution in consumption, which is set at 0.7, the rate of impatience or subjective utility discount rate, set at 2% per year, the share of non-social security government consumption in GDP, set at 13 %, the

¹⁰ This equivalence is due to the absence of borrowing constraints in long term consumer credit market. In this model savers are endowed with perfect foresight of their old age and perfect ability to implement any saving strategy to cover their needs during old age. With borrowing constraints, instead, a mandatory funded pension system becomes different from the absence of a social security system.

rate of labor productivity growth, set at 2% per year and the rate of capital depreciation per year, set at 3.5% per year. No sensitivity analysis is performed for the average shape of the wage path in the life cycle, which was taken to be equal to the one estimated by Arrau (1991) for Chile, nor for the ratio of active years to inactive years, which is $45/10 = 4.5$ in the model.

In the base scenario, we assume that population grows at 2%, the ratio of government debt to GNP is 25% and the share of payments to labor in total income is 65%. We present sensitivity analyses for changes in these parameters. The economy is closed, so equilibrium in the capital market requires that the net supply of funds by households of all ages equals outside demand for funds, from firms and the government (national debt). The real interest rate adjusts to clear this market, making endogenous the real wage and the stock of physical capital per worker. The model determines endogenously a single income-tax rate that keeps the budget in equilibrium, given a path for the government debt. This tax does not address demands for redistribution.

Regarding labor productivity growth, we assume that successive generations are 2% richer than the previous generation, for each of the income classes. This implies income inequality does not evolve over time because of differential productivity growth. If we understand income inequality in this deep sense, it will not be affected by any of our policy exercises.

This paper innovates by introducing a distribution of income. Four new parameters are defined. The average economy wage level is taken as the *numeraire* of the economy:

- a) The share of the poor and middle class populations in the total population. These shares are s_p and s_m . The share of the rich - s_r - is the residual.
- b) The wage level for each income class, at the age when workers start their active life. In this respect, we make the following assumptions:

middle class	average wage of the economy
poor	"z" times the middle class wage
rich	residual wage such that the economy-wide average wage is preserved

A lower z increases inequality at the age at which workers start work, because this reduces the initial wage of the poor and raises the initial wage of the rich.

- c) The growth rate of labor endowment, for each income class, in response to experience (age). The economy-wide age-wage profile is taken from Arrau and Schmidt-Hebbel (1993). The assumptions for the growth rate of labor endowment, for each income class, are the following:

middle class	same as growth rate of the average for the economy
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poor	" σ " times the growth rate of the labor endowment of the middle class
rich	residual growth rate of the labor endowment that preserves the economy-wide average growth rate

Parameter z fixes the relative earnings at the youngest age of the poor and the rich *vis a vis* the middle class. Parameter σ governs the relative flatness of the labor earnings path of the poor. In addition, σ affects the relative steepness of the labor earnings path of the rich. Both parameters yield the relative earnings for all ages and income classes.

For σ less than one, a rise in σ increases the wealth of the poor and impoverishes the rich, in comparison to the middle class, for any given value of z , the distribution of income at the youngest age. Parameter σ cannot be much above one in order to avoid the initially rich from becoming poorer than the middle class by age 64. The base case assumes a value of 0.80.

Parameter σ was varied in one sensitivity analysis.

For the $\sigma=1$ case, it is easy to show that the share of the wage bill of the poor in the national wage bill is z times s_p , the % of poor in the population. As β is the share of labor income in GDP, the wage bill earned by the poor as a percentage of GDP is $\beta z s_p$ for the case of $\sigma = 1$, and is even less if $\sigma = 0.8$.

Summing up, we have designed a scenario where income distribution at the individual level is governed by just two parameters: z and σ . Income distribution at the aggregate level is also a function of the relative abundance of each of the income classes, which is captured by a separate set of parameters (s_p and s_m).

3.2 Redistribution in the initial PAYG pension system.

This section explains our assumptions regarding the design of the initial PAYG pension system.

The first parameter to consider is the contribution rate, denoted by c . A large contribution rate implies a large pension system. As all workers contribute to the pension system in this economy, the receipts of the system are a fraction c of the wage bill. But the wage bill is β , a fixed fraction of GNP because we use a Cobb-Douglas production technology. Therefore, the share of pension contributions in GNP is βc .

Benefits (pensions) are made up of two parts, a basic pension plus a sum proportional to the last wage while active. Benefits are:

$$(1) \quad B(a,i) = \text{BasPen}(c,z) + \theta \cdot LW(a,i,z,\sigma)$$

where

$B(a,i)$ = benefit (pension) paid to a person of age a , $a=66,..75$ which belongs to income class i , for $i= P,M,R$ (poor, middle income and rich, respectively).

$BasPen(c,z)$ = a basic flat pension, equal for everybody, which is relatively more important for the poor than for the rich. The size of the basic pension depends of the degree of income inequality, as discussed below.

$\theta(c,z,\sigma)$ = proportionality constant between 0 and 1.

$LW(a,i, z, \sigma)$ = last wage while working, net of income taxes and pension contributions, of a pensioner of age a and income class i , $i=P,M,R$. The last wage depends on age because of productivity growth, so at any point in time the last wage for older pensioners is smaller than the last wage for younger pensioners. It also depends of z and σ for income classes Poor and Rich, as discussed previously.

We study a PAYG system where the basic pension and the proportionality constant are determined as follows:

$$(2) \quad BasPen = \begin{cases} \text{Revenue}/N & \text{if resulting basic pension} < LW(65,P,z,\sigma) \\ LW(65,P,z,\sigma) & \text{if not.} \end{cases}$$

$$(3) \quad \theta = \begin{cases} 0 & \text{if resulting basic pension} < LW(65,P,z,\sigma) \\ \frac{\text{Revenue} - BasPen \cdot N}{\sum_i \sum_a LW(a,i) \cdot n(a,i)} & \text{if not.} \end{cases}$$

where Revenue = total revenue from social security taxes = $c \cdot \beta \cdot GNP$
 N = total number of pensioners.
 $n(a,i)$ = number of pensioners of age a in income class i , $i=P,M,R$.
 $LW(a,i)$ = last wage of pensioners of age a in class i , $i=P,M,R$.

The first branch of equations (2) and (3) apply when the contribution rate is too low to finance the target basic flat pension for all. In this case, all revenue must be spent in the flat pension. This target pension is 100% of the last wage (age 65) of a poor person, which in turn is given by the income distribution parameters (z,σ) .

For higher contribution rates, total revenue can sustain a basic pension equal or larger than the last wage of the youngest poor while in activity. If a flat pension were paid, the replacement rate for the poor would surpass 100%. In this case the second branch of equations (2) and (3) apply, which means that the surplus of revenue after the cost of basic pensions is subtracted, is shared among all pensioners according to their last after-tax wages. The last after-tax wage is not proportional to each person's share in past contributions, because of differences in the growth rate of wages.

These benefit formulas seem to be the simplest within the class of redistributive formulas, because pension benefits have only one breaking point as a function of c , the contribution rate. A more complex formula would

put a cap on the total pension (the sum of the basic pension plus the earnings related part), creating a second break point. In our simple formulation, the poor and the rich always get both an earnings-related pension and a basic pension.

This is a very redistributive benefit formula, because revenue is a shared according to the last wages only after the basic pension has risen to 100% of the last wages of the poor. This is very optimistic, considering the empirical evidence about redistribution through social security in developing countries presented by Mesa-Lago (1978), so we have stacked the deck in favor of the redistributive abilities of PAYG pension systems.

On the other hand, when we compare across countries that exhibit different values of z , i.e. different degrees of income inequality, this benefit formula implies that the basic pension must increase when inequality falls. This is because lower inequality (a higher z) implies a relatively higher last wage for the poor, so the rule that the basic pension is 100% of the last wage of the poor implies that the basic pension must increase.

This captures our presumption that across countries, there is a negative correlation between the degree of income inequality and the value of the basic pension in relation to average income. This is presumably the result of political economy considerations. It seems politically unlikely for a country to sustain a basic pension that pays benefits that are much more than 100% of the last wage of any significant social group. In our simulations, the average pension for the poor old is 172% of their last wage in the case where income inequality is highest ($z=0.1$) and the available revenues are largest ($c=5\%$). This is made up of 100% replacement through the basic pension plus 72% replacement through the earnings-related portion of the pension. We do not think it is realistic to assume redistribution through a pension system can be more generous than this.

This implies that our simulations represent cross-country comparisons where the value of the basic pension is endogenous. Our simulations should not be used for comparisons among persons of different incomes within a given country.

It is also useful to consider the relation between the pension of the poor and the contribution rate c . When c is low, an increase in c translates into a less than proportional rise of the basic pension. This is due to the following facts: (a) the number of pensioners is fixed; (b) the share of revenue in GNP is proportional to c ; and (c) GNP falls as c rises because a bigger PAYG pension system crowds out more physical capital in the steady state.

Once the pension of the poor rises to equal the level of the last wage while active, further increases in c have a smaller impact than before on the total pensions of the poor. The reason is that the extra revenue is not shared in proportion to the numbers of pensioners but in proportion to past wages, where the poor have a small representation.

A different insight is obtained by analyzing the path of individual wages and pensions according to age, for a given large contribution rate. From (1) it can be seen that the replacement rate is $(1+\theta)$ for a poor that just retired. In addition, the basic pension must rise each year because it must equal the last wage of the youngest cohort of retired poor and the last wage of the youngest cohort of retirees by 2% per year because of labor productivity growth. This implies that the path of real pensions rises over time for poor retirees. In fact, the poor are the only group that earns a pension effectively indexed to wages and not to prices. The end result is that the poor enjoy a higher ratio of average pensions to average wages than what may appear.

For the rich, the basic pension is insignificant, so their total pension is slightly higher than θ times their last wage while active. Therefore, their replacement rate is low unless c is high. However, the rate of return of contributions may still be large for the rich, because they enjoy a rate of growth of wages above average when $\sigma < 1$, as we assume in most simulations. This allows the rich to have a last wage that is much higher in relation to the average wage for the working life, in comparison to the other income classes.

The replacement rates associated to these redistributive formulae are reported in Table 1, for the initial steady state equilibrium of the base case. The conclusion from Table 1 is that a redistributive PAYG pension system that charges a contribution rate of 5% yields a replacement rate of 70% for the middle-income groups, and only 39% for the rich, when z is 0.5. Smaller contribution rates like 3% reduce the replacement rates to 40% for the middle class and 10% for the rich, figures which may be considered politically insufficient. We expect political considerations to put a lower bound on the size of the redistributive PAYG pension system.

Two invariance results were found. First, it can be seen that the replacement rates for the middle class are almost independent of parameter z , the degree of inequality, and depend mostly of the size of the pension system as measured by c . The reason why independence from z obtains is the following:

A change of z changes the replacement rates for the poor and rich, which in turn affect their savings rates over the life cycle. These effects work in the opposite direction for the poor and the rich. They do not cancel out exactly because the aggregate supply of savings at each age is affected, generating a small macroeconomic effect on the capital stock, real wages and the equilibrium interest rate. Using the same reasoning it can be shown that the replacement rate for the rich depends of the share of the poor in the population.

Secondly, the simulation results are almost invariant to the share of the population that is poor. The results in Table 1 are almost correct for all feasible shares of the poor and the rich in the population.

To see why this invariance exists, note first that a change in the share of the poor in the population does not affect the size of the wage bill nor the revenue of the pension system in relation to GNP. This is because the reduction in the

labor supplied by the poor is compensated by an increase in the labor supplied by the rich, while the labor supplied by the middle class is held fixed. For given (z, σ) and a given share of the middle class in the population, an increase in the share of the poor population preserves the average wage. The net macroeconomic effect is almost zero.

In addition, a change of the share of the middle class in the population does not affect the wages of anybody, modifying only the number of rich and poor which in turn cancel each other out. The average wage of the poor relative to the national average wage is z at all ages, regardless of the number of poor.

These invariance results are a major advantage of our parametrization of the income distribution.

4. Simulation Results

This section seeks an answer to the following question: how large should a targeted transfers/progressive tax system be to keep the poor equally well-off than under a redistributive conventional PAYG pension system, which would be replaced by a neutral funded pension scheme?

This question assumes that compensation for the poor will be targeted. It also assumes that some compensation will be required, because the funded pension scheme is neutral from a redistributive point of view. Our finding is that in most plausible cases, such compensation is needed only during the transition from one pension system to the next.

In the following simulations we compare the steady-state effects of substituting the redistributive PAYG-financed pension system with a funded pension system that is not redistributive. The new pension system leaves responsibility for implementing solidarity to the tax/transfer system.

Substitution of the PAYG-financed system for a funded scheme causes an increase in the capital stock, GNP per capita and wages when the regime change is tax-financed. This must be the method of financing because we assume a constant ratio of public debt to GNP across steady states. This implies that intermediate generations pay for the fiscal cost of the transition through higher taxes or lower pension benefits or a smaller supply of public services. The increases in the capital stock, GNP per capita and real wages would still exist if the public debt to rise moderately in relation to GNP, but their magnitude would be reduced.

From the point of view of redistribution within a generation, the rise in wages under at least partial tax-financing opens up the possibility that the steady-state poor might gain even though the redistributive features of the PAYG pension system have been entirely eliminated when moving to full funding. This will be the case when the loss of redistribution towards the poor is compensated by promoting them to work in an economy that enjoys a higher GNP per capita. As the positive effect of a pension reform on GNP per capita

is larger when the contribution rate and the size of the original pension system is larger, we expect a sufficiently large redistributive PAYG system to be inferior to a neutral funded pension system, from the point of view of the poor alive in the new steady state.

The quantitative question is how large is sufficiently large.

4.1 Results in the Base Case

Table 2 presents the effects the on individual welfare, measured by the level of indirect utility function (see Arrau and Schmidt-Hebbel, 1993 for the definitions) and for the base case.

c^* is defined as the critical contribution rate for which the PAYG pension system is sufficiently large so that its negative effect on capital accumulation is so substantial that the poor are indifferent when the redistributive PAYG pension system is replaced by a fully-funded and neutral system. The implication of c^* being zero is that the poor alive in the steady state are always better off after the redistributive PAYG-financed pensions are replaced by non-solidary fully funded pensions.

Table 2 shows that c^* is small, at least smaller than what we expected before starting this research. In fact c^* is zero for values of z above 0.27. It may seem surprising that a poor person that earns 10% of the middle income wage can be compensated for the loss of redistribution in his favor by a rise in wages. However, it must be recalled that our parametrization incorporates a restriction on the design of redistribution, which is that the basic pension can at most be 100 % of the last wage of the poorest significant social group. This implies that the total pension received by the poor is at most $(1+\theta)$ times their last wage, regardless of the degree of income inequality. As this is appropriate for cross-country comparisons, our result that c^* is very low stands up as applicable to a wide range of countries.

Note also that for a given (c,z) the steady-state welfare gains of all three income classes of switching to a neutral and funded pension system are similar in size, although they are always higher for the rich, as expected¹¹. This is because all three income classes are benefited by a common factor: the changes in real wages and real interest rates brought by capital accumulation. When the PAYG system is replaced by the neutral fully-funded scheme, the capital-output ratio increases from 2.46 to 2.62 and the real interest rate falls from 10.7% to 9.9% before tax.

Previous discussion showed that a redistributive PAYG system should have a contribution rate of at least 5% to offer acceptable replacement rates for the middle income groups. The implication is that for PAYG systems that yield politically acceptable pension benefits for the middle class, all groups alive in the new steady state gain from substituting the PAYG pension system, including the poor.

¹¹ As mentioned before, this effect would be smaller if the income tax were progressive.

Our interpretation of this result is that inter-generational redistribution dominates intra-generational redistribution. This implies that the critical issue in a transition is not the eventual loss of features of the benefit formula that redistribute within a given generation. The critical point is what happens with the generations living during the transition.

To explore further the issue of the relative importance of inter-generational and intra-generational redistribution, we consider now the case where the public debt/GNP ratio increases when the PAYG system is substituted, supposedly because public debt is issued to finance short-run assistance to the poor alive during the transition. We pose the following question: How much can the debt/GNP ratio rise across steady states, so that the poor in the steady state do not lose from the replacement of a redistributive PAYG system for a funded system that is neutral ?

The answer, provided in Table 3, assumes a contribution rate of 5%, which the initial PAYG system requires in order to guarantee acceptable replacement rates for the middle-income class.

The first result is that the steady-state poor are only hurt when debt-financing is large, i.e. when debt/GNP ratio rises from 25% to above 65%. The degree of use of debt-financing during the transition, instead of taxes, is expressed here through the increase in the debt/GNP ratio.

$(D/GNP)^*$ is the critical public debt to GNP ratio, which leaves the poor that live in a steady-state indifferent after substitution of the redistributive PAYG system by a neutral funded scheme. At this critical ratio the rich and the middle-income groups are better off. The critical ratios vary slightly around 65% for different values of z .

The new debt/GNP ratio that leaves the middle income class that live in a steady state indifferent between both pension systems is 79%, for the case with $z=0.5$. In this same case, the rich become worse off only if the debt/GNP ratio rose above 83.5%. These critical values would be closer to each other if the income-tax system exhibited a rising marginal income tax, as mentioned before.

Regarding the macroeconomics of the result, we can see that (for $z=0.5$) the new capital/output ratio falls to 2.43 when the debt/GNP ratio is 75%, which is slightly below the value of 2.46 for the progressive unfunded system. The two steady states are different because of two reasons:

First, the explicit public debt must pay a market interest rate which is higher than the forced interest rate paid by the government on the implicit public debt associated to the unfunded system, given by steady state growth rate (equal to 4.04% per year). This explains why the income tax rate is 18.2% in the fully-funded equilibrium with $D/GNP = 75\%$ and only 15.6% in the unfunded equilibrium with $D/GNP = 25\%$. The welfare level of the middle-income class is very similar under both pension systems, despite the higher tax rate of the first one. The reason is that the income effect of higher taxes is

balanced by the elimination of the burden of forced pension savings, which yields less than market interest rates.

Second, the larger income-tax rate required by the fully-funded steady state introduces a larger wedge between pre-tax and after-tax interest rates, generating an additional welfare loss. A similar welfare loss occurs with any tax method, because all of them are distortionary.

The values of $(D/GNP)^*$ turn out to be substantial. The difference with the initial 25% varies slightly around 40 percentage points of GNP. This implies that the government has available roughly 40 percentage points of GNP to compensate the poor alive during the transition.

Of course, compensating everybody alive during the transition is impossible in this setting, where the labor supply is inelastic, as shown by Breyer (1989)¹². The new result is that only the rich and the middle income classes alive during the transition need bear its cost, while the poor alive both in the transition and in the steady state can obtain net gains if a suitable targeted transfer program is used to take care of the transition poor.

4.2 Sensitivity Analysis

We perform now two types of sensitivity analysis. First, we consider a 'most favorable case' for the intra-generational distributive function of the initial pension system, seeking that the critical size c^* of the PAYG system be as large as possible. To achieve this, we choose parameter values which minimize the impact of inter-generational redistribution and maximize the beneficial effect of intra-generational redistribution on the welfare of the poor. Three values were changed simultaneously, after checking that each change contributed to raise the welfare of the poor in the initial system when shifted individually:

- (a) The public debt/GNP ratio was reduced from 0.25 to zero. This change reduces the incremental impact of the additional public debt implicit in a PAYG system, so its substitution should generate a smaller increase in steady-state welfare. On the other hand, initial debt/GNP ratios below zero seem implausible.
- (b) The share of labor in income was raised from 0.65 to 0.75. This change increases the wage bill for any level of GNP, which in turn raises the revenue of the PAYG system for any given contribution rate, allowing payment of higher pensions to the poor.
- (c) The growth rate of the population was raised from 2% to 3%. This raises overall labor supply (offered by the young) relative to capital (offered by the

¹² Compensation for all is possible when labor supply is distorted by the implicit pension tax, as shown by Breyer and Straub (1993).

old), raising GNP and the wage bill. This raises the rate of return on PAYG contributions, allowing payment of higher pensions to the poor¹³.

The results reported in Table 4 (which should be compared to table 2) show that the replacement of a very redistributive pension system by a neutral fully funded scheme helps the steady-state poor whenever the contribution rate is above 3.48%. The welfare loss for the steady state poor in cases with high income inequality is still slight when the contribution rate is as low as 3%.

It should be noted, however, that the welfare loss for the poor can be substantial (2.11%) if the initial steady state meets the conditions of (a) high income inequality; (b) full coverage of the poor, in the sense that all the poor get benefits from the redistributive PAYG system; and (c) a low contribution rate like 1%, i.e. revenues are around 0.65% of GNP.

To evaluate these results consider the replacement rates obtained under these parameter values, reported in Table 5 (which should be compared to Table 1).

These figures suggest that in order to obtain 'reasonable' replacement rates for the middle-income groups, contribution rates of at least 3.5% are required in the "Most Favorable Redistributive PAYG System"

The conclusion from the 'most favorable' simulation exercise is that replacing a redistributive PAYG system that pays reasonable pensions, by a neutral funded system, always helps the steady-state poor. In other words, there seems to be no parameter values which simulatenously yield plausible replacement rates in the initial equilibrium and where a shift to full funding hurts the steady-state poor.

The second sensitivity analysis consists in changing " σ ", the relative rate of growth of the wages of the poor *vis a vis* the middle income group, from 0.8 to 1.0. A value of $\sigma = 1.0$ assures that all income classes have a common profile of labor income during the life cycle. One effect of this, compared to the base case, is that the last wages of the poor are raised, so the basic pension is higher relative to their average lifetime labor income. This effect may increase the amount of redistribution towards the steady-state poor effected by the PAYG System.

The net effect is not clear-cut, however, because a higher σ makes the poor less poor for a given initial wage. This means that redistribution may benefit the poor by less taking lifetime wealth as the basis of comparison. In addition, raising the growth rate of wages for the poor increases the incentives for dissaving of the poor while young. On the other hand, as this

¹³ We also tried to affect the results by changing the rate of labor productivity growth, but the results were mixed. An increase in the value of this parameter raises the steepness of the path of labor income, generating an incentive for the young to get deeper into debt, reducing aggregate saving and the supply of capital. This increase also raises the supply of effective labor i.e the supply measured in efficiency units, but the net effect on GNP is ambiguous. Changing this parameter alone did not increase the critical contribution rate c^* .

also reduces the growth rate of wages for the rich, it also increases the incentives for the rich to save when young. The net effects on aggregate savings may not cancel out exactly.

The results with $\sigma=1$ are reported in Table 6. They are extremely similar to the base case. In any case, the net effect of raising σ from 0.8 to 1 is to reduce slightly the advantages of the redistributive PAYG pension system for the poor, and hence to increase slightly their welfare gains from the regime change.

Other sensitivity analyses not reported here show that other parameter changes do not affect in any significant way the base-case results.

4.3 The Cost of Supporting the Poor in the Short Run

This section offers a back-of-the-envelope estimation of the feasibility of compensating the poor in the short run, using the 40 percentage points of GDP that are available from the increase in the national debt.

The first point to be made is that the increase in the national debt has macroeconomic effects that have already been taken into consideration to find the final steady state. The factor prices achieved in the long run will be no different if the resources obtained by the government with this increase in debt were thrown to the sea or were spent in a program that helps the poor alive during the transition, given that those poor do not leave bequests to their descendants.

The starting point of our estimate is that the wage bill earned by the poor as a percentage of GDP is $\beta z s_p$, for the case of $\sigma = 1$, and is even less if $\sigma = 0.8$.

In second place, the transfers lost by the transition poor due to the disappearance of the redistributive feature of the social security system are at most equal to the basic pension. In turn, the basic pension is at most equal to $LW(65, P, z, \sigma)$, the last labor earnings of the poor.

In one year, the fiscal cost of the basic pension received by the poor - excluding those received by the middle and high income classes - is bounded above by the following expression:

$$\frac{\text{Fiscal Cost}}{\text{GNP}} \leq \frac{\text{Wage Bill of all Poor}}{\text{GNP}} \times \frac{LW(65, P, z, \sigma) \cdot N \text{ poor old}}{\text{Wage Bill of all Poor}}$$

The first ratio is in turn bounded above by $\beta z s_p$. The second ratio is the following function of demographic, experience and income distribution variables:

$$\frac{LW \cdot N \text{ poor old}}{\text{Wage Bill of the Poor}} = \frac{w \cdot z \cdot e_p^{65} \cdot [1 - (1+n)^{-10}]/n}{w \cdot z \cdot \sum_{a=21 \text{ to } 65} e_p^a \cdot (1+n)^{65-a}}$$

Where e_p^a is the earnings level of a poor pensioner of age a .
 e_p^a is obtained from the age-earnings profile for the middle income class through the formulae:

$$e_p^a = e_p^{a-1} \cdot [1 + \sigma \cdot (e_m^a / e_m^{a-1} - 1)]; \quad e_p^1 = z \cdot e_m^1$$

For the base case we discuss in detail, $\sigma = 0.8$ and $n = 2\%$. For the age-earnings profile used in our simulations, we find that this second ratio has a value of 0.14997.

This implies that the upper bound for the fiscal cost / GNP of maintaining the transfers associated to the initial social security is $\beta z_{sp} 0.14997$. Using the value of β used in our simulations, of 0.65, this upper bound is $0.0975 z_{sp} \%$ of GNP.

This means that if the initial income inequality is larger (z is smaller) then the fiscal cost of compensating the poor falls, because the basic pension that must be replaced is smaller. On the other hand, if the relative size of the poor population is larger, then the fiscal cost of compensation grows proportionately.

The final element for an assessment of the total volume of resources required for compensation is an estimate of the duration of the transition between steady states. The simulations of transitions into PAYG-financed social security by Auerbach and Kotlikoff (1987, p. 152) suggests that most of the change associated to that pension reform occurs within 20 years. The transitions from PAYG to full funding studied by Cifuentes (1993, p. 163 and 183) take at most 50 years. We will use the second estimate - 50 years - to be on the safe side.

The fact that real wages grow when PAYG financing is abandoned implies that the poor are gradually made better off by capital accumulation. In both cases the path of the real wage rate is above a linear interpolation between the extreme years. Therefore, an upper bound for the volume of compensation required is a linear function that starts at the initial value, and falls to zero by year 50.

With this assumption, we find that the required compensation is $0.0975 z_{sp}$ in year one of the transition, which falls linearly to zero in year 50 of the transition. The sum of all these annual compensations, measured as fractions of GDP, is $(1/2) \cdot 50 \cdot 0.0975 z_{sp} = 2.4375 z_{sp}$.

As 40 percentage points of GDP of resources are available for distribution and consumption during the transition, we conclude that this will be enough to compensate the poor in the short run as long as:

$$z \cdot z_{sp} \leq 0.1641$$

In most developing countries z is expected to be between 0.10 and 0.30. For the case of $z=0.1$, the poor can always be compensated. For the case of $z=0.3$, they can be compensated as long as they comprise less than 54.7% of the population.

5. Summary and Conclusions

This study yields a strong result: In most cases, the poor living in the steady state improve their welfare when a redistributive but unfunded system is replaced by a funded pension system that is neutral (i.e. non-redistributive), that is, even if no targeted transfer/progressive tax system remains in the long run. However, the steady-state poor are hurt when debt-financing of the transition is large enough.

The intuition for the result is the following: in the long run (steady state) the poor benefit from the shift from unfunded to funded finance, because the stock of physical capital can increase, raising GNP per capita and real wages and reducing real interest rates. For those poor, this benefit is larger than the loss of the redistributive net benefit of the conventional PAYG system, for most parameter configurations.

As in this model the underlying degree of income inequality is kept constant, this does not mean that in the long run the poor are made better off as compared to the middle income class. They are merely better off than they would have been if no pension reforms had existed.

This result continues to hold for countries of very different degrees of income inequality, because we take into account that the level of the basic pension in relation to average wages will be smaller when income inequality is larger. This may be related to political considerations. It is unlikely for a country to sustain a basic pension that pays benefits that are more than 200% of the last wage of any significant social group. In our simulations, the average pension for the poor old ranges between 35% and 172% of their last wage, in the base case. We do not think it is realistic to assume redistribution through the pension system can be more generous than the upper bound of this range.

We interpret these results as showing that inter-generational redistribution is more important for the welfare of the poor than intra-generational redistribution, for most parameter values. The dominance of intergenerational redistribution is also clear from the fact that large increases in the public debt during the transition may reverse our results. We find that the public debt can rise by at most 40 percentage points of GDP during the transition without reversing our results. This is the maximum amount of resources that may be used to compensate the poor in the short run, who suffer an immediate loss of basic pensions before real wages increase.

There is an obvious need for a socially sensitive transfer program to help the poor alive during the transition. The final section of this paper shows that the resources available from the increase in the public debt are in many cases

more than enough to finance a 'transitory' program (50 year duration) that would compensate the poor for the loss of the progressive redistribution associated to the initial pension system, net of gains due to the rising real wage.

As the transition is financed through taxes, those alive during the transition that are rich or middle income are the net losers from the reform.

From the previous discussion it is clear that the program that compensates the poor old during the transition period must be targeted to the poor old. A universal transfer program is too expensive. This implies that redistribution through a 'social security' system would have no role in this pension reform, either in the short or in the long run. The 'first pillar' must be a targeted transfer program.

The main conclusion is that, regarding proposals to replace conventional PAYG systems for fully funded schemes, the concern for redistribution toward the poor old is misplaced. Concern should be placed on redistribution across generations.

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APPENDIX

This appendix offers a short description of the main equations of the model.

Households (Individuals)

The individual is born of age 21, works until age 65 and is retired from age 66 to 75, when he dies. He is endowed with units of labor, which grows due to experience from age 1 to 55, to decrease slightly until age 65. There is no endowment of labor after retirement. As labor is supplied inelastically, his only decisions concern savings and consumption in each year. This decision is represented by:

$$\begin{aligned} \max U &= (1-\gamma)^{-1} \cdot \sum_{t=21 \text{ to } 75} (c_t)^{(1-\gamma)} (1+\delta)^{-(t-1)} \\ \text{subject to: } a_{t+1} &= a_t \cdot (1+rt) + w_t \cdot e_t - c_t - \text{contributions} + \text{pensions} - \text{taxes} \\ \text{and } a_{21} &= 0 \end{aligned}$$

Where a_t = assets held at the beginning of period t ; rt is the real gross return on assets, w_t is the wage rate per period of effective labor; e_t is the endowment of labor for age t and c_t is consumption in age t . As there is no uncertainty and the consumer has perfect foresight, he knows the complete path of future wages and rates of returns.

The optimization conditions for this problem include $a_{76}^* = 0$ (no bequests) and:

$$c_{t+1}^* / c_t^* = (1 + rt_{t+1} \text{ after tax} / 1 + \delta)^\gamma$$

This path for consumption implies an optimal path for assets at each age s in each year t (a_{st}^*).

Firms

Firms rent capital and hire labor to produce output with a Cobb-Douglas technology. Output has price 1 and their problem is to choose how much capital and labor to demand in order to produce one unit of output. This is represented by:

$$\text{Max } \pi_t = 1 \cdot Y_t - w_t \cdot L_t - r_t \cdot K_t \quad \text{subject to } Y_t = K_t^{1-\beta} \cdot L_t^\beta$$

The optimization conditions of this problem lead to factor demands: $K^d = [(1-\beta)/r_t]Y_t$ and $L^d = [\beta/w_t]Y_t$. In addition, free entry assures that $\pi = 0$.

Government

The government budget is:

$$B_{t+1} = B_t(1 + rt) + G_t - \text{Taxes} + \text{pensions} - \text{contributions}$$

where B_t = is the stock of public debt and G_t is the flow of government consumption.

Under PAYG financing of social security, the following budget condition holds only in the steady state:

Pensions = contributions

Labor Market Equilibrium

The supply of labor, which is given by population, the population growth rate and labor-augmenting technical progress, must be employed, so the wage rate adjusts accordingly:

$$L^d_t = \sum_{s=21 \text{ to } 65} e^s_t (1+n)^{t-s+1}$$

where n = population growth rate, e^s_t is the labor endowment of people of age s in year t . This depends of experience - the age earnings profile - and of technical progress, so $e^s_t = e^s (1+x)^{t-s+1}$.

Capital Market Equilibrium

The stock supply of securities, which are issued by firms and the government, must be held by households, so the interest rate adjusts accordingly:

$$\sum_{s=21 \text{ to } 75} a^s_t (1+n)^{t-s+1} = K^d_t + B_t$$

Table 1: Replacement Rates of the Redistributive PAYG System
 (The number shown is the Average Pension during Retirement over last After-Tax wage , in % points. $\sigma = 0.8$)

Value of z (<u>First wage of P</u> First wage of M)	Income Class	<u>Contribution Rate (c)</u>		
		1 %	3%	5%
0.5	R	3.3	10.1	39.0
	M	13.5	41.4	70.6
	P	35.2	108.1	138.2
0.3	R	2.8	21.3	50.5
	M	13.5	41.3	70.5
	P	58.6	125.7	154.9
0.2	R	2.6	24.5	56.9
	M	13.5	41.3	70.5
	P	70.3	134.0	159.0

Note: The equilibrium values of the macroeconomic variables for the case with $c=5\%$ and $z=0.5$ are the following: capital/output ratio = 2.46; real interest rate before taxes = 10.7%; income tax rate = 15.6%.

**Table 2: Welfare Effects of Substituting Redistributive PAYG
-financed pensions by a neutral fully-funded scheme, when the
Transition is completely financed by Taxes**

(The number shown is the Equivalent Variation, in %
points of lifetime wealth in the initial PAYG steady-state)

		<u>Contribution Rate (c)</u>			c*
Value of z (First wage of P First wage of M)	Income Class	1 %	3%	5%	
0.5	R	1.49	4.55	7.22	0
	M	1.19	3.67	6.28	
	P	0.62	2.05	4.55	
0.3	R	1.48	4.20	6.83	0
	M	1.19	3.67	6.28	
	P	0.12	1.67	4.23	
0.1	R	1.36	3.84	6.45	1.80%
	M	1.19	3.67	6.27	
	P	-1.09	1.36	3.92	

Note: The values of the macroeconomic variables for the case with $c=5\%$ and $z=0.5$ were the following: capital/output ratio = 2.62; real interest rate before taxes = 9.9%.

c^* = the contribution rate for which the PAYG pension system is sufficiently large so that its negative effect on capital accumulation is so substantial that the poor are indifferent when the redistributive PAYG pension system is replaced by a fully-funded and neutral system.

Table 3: Welfare Effects of substituting a Redistributive PAYG System by a Neutral Fully-Funded Scheme, when the Transition is financed in part by new Public Debt
 (D/GNP rises across steady states from initial value of 0.25 .
 Contribution rate is 5%. $\sigma = 0.8$. Number shown is the Equivalent variation in % of lifetime wealth in the initial steady-state)

		<u>New Steady-State Debt/GNP Ratio</u>					
<u>Value of z</u>	<u>Income Class</u>	<u>25 %</u>	<u>35%</u>	<u>45%</u>	<u>55%</u>	<u>75%</u>	<u>(D/GNP)*</u>
0.5	R	7.22	6.05	4.86	3.64	1.11	68.5%
	M	6.28	5.17	4.04	2.88	0.47	
	P	4.55	3.55	2.52	1.47	-0.73	
0.3	R	6.83	5.69	4.52	3.33	0.86	65.7%
	M	6.28	5.17	4.04	2.87	0.46	
	P	4.23	3.24	2.21	1.16	-1.03	
0.1	R	6.45	5.34	4.19	3.02	0.60	63.0%
	M	6.27	5.17	4.03	2.87	0.46	
	P	3.91	2.92	1.90	0.85	-1.33	

Memorandum: Macro variables for $z=0.5$ are:

K/Y	2.62	2.58	2.54	2.51	2.43
r (%)	9.88	10.07	10.26	10.47	10.90

**Table 4: Welfare Effects of Substituting the Most
Favorable Redistributive PAYG by a Neutral Fully-Funded
Scheme, when the Transition is financed by taxes**
 (D/GNP = 0.0 across steady states; $\sigma = 0.8$)
 (Equivalent variation, % of lifetime Wealth in the
 initial PAYG steady-state)

Value of z	Income Class	<u>Contribution Rate (c)</u>			c*
		1 %	3%	5%	
0.5	R	1.28	3.55	5.37	2.70%
	M	0.76	2.40	4.19	
	P	-0.22	0.24	1.98	
0.3	R	1.26	3.08	4.89	3.24%
	M	0.76	2.40	4.19	
	P	-1.13	-0.20	1.57	
0.2	R	1.22	2.85	4.65	3.48%
	M	0.76	2.40	4.19	
	P	-2.11	-0.43	1.38	

**Table 5: Replacement Rates of the Most Favorable
Redistributive PAYG system**

(Number shown is the Average Pension during Retirement over
last After-Tax wage, in % points)

value of z	Income Class	<u>Contribution Rate (c)</u>			
		1 %	3%	3.5%	5%
0.5	R	4.3	22.4	31.8	60.5
	M	17.7	54.1	63.5	92.1
	P	46.1	121.7	131.0	159.7
0.3	R	3.6	34.0	43.3	72.0
	M	17.7	54.0	63.3	92.0
	P	58.6	125.7	147.7	76.3
0.2	R	4.1	40.3	49.7	78.4
	M	17.6	53.9	63.3	92.0
	P	110.4	146.6	166.0	184.7

Table 6: Welfare Effects of substituting a PAYG with $\sigma=1.0$
(D/GNP = 0.25 across steady states)
(Number shown is the Equivalent variation in % of
initial steady- state lifetime wealth)

Value of z	Income Class	Contribution Rate (c)			c*
		1 %	3%	5%	
0.5	R	1.42	4.34	7.11	0
	M	1.19	3.67	6.28	
	P	0.87	2.75	5.15	
0.3	R	1.44	4.24	6.81	0
	M	1.19	3.67	6.28	
	P	0.44	1.98	4.69	
0.2	R	1.45	4.06	6.64	1.67%
	M	1.19	3.67	6.28	
	P	-0.08	1.74	4.47	

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